A Strategic Planning Methodology for the Computing Effort in Higher Education: An Empirical Evaluation

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The findings of a study designed to address the pressing problems associated with the strategic planning of the computing effort in higher education are presented here. A planning methodology was developed and tested through implementation at a university. Two years after the methodology was implemented, the effectiveness of the planning methodology was assessed in terms of the improvement of the delivery of computing services to the major institutional roles of instruction, research, and administration. Two control institutions were employed to contrast the improvements at the test institution. The results of the research indicate the planning methodology significantly enhanced the delivery of computing services.

Key Words and Phrases: computer management, computer budget, university computing, computer planning

CR Categories: 2.41, 3.51

Introduction

The results of computing efforts in more organizations have fallen substantially below management's original expectations. This disenchantment has been amplified by the increasing cost associated with most computing activities [11]. In higher education the cost of academic and administrative computing has increased to the point where it frequently consumes 4 to 5 percent of the institutional budget [3].

The most common management criterion for evaluating the success or failure of an organizational function is the degree of variation between planned and actual performance. Unfortunately the computing effort has been conspicuously void of comprehensive planning and control activities in most organizations [5]. It is somewhat alarming to see an activity as pervasive and sophisticated as computing provided with less management scrutiny than other organizational functions. However, the computing effort has presented new complexities and problems that often defy attempts at comprehensive planning [2, 9]. In spite of the difficulties associated with the planning of the computing effort, the combination of increasing costs and dissatisfaction with results increasingly is compelling organizations to at least experiment with formalized approaches for planning the computing effort [13]. University computing, where the computing effort must support both administrative and academic activities, has been characterized as the most difficult environment in which to achieve comprehensive planning [5].

The objective of this paper is to present the findings of a study designed to develop and field test a planning methodology for the computing effort in higher education. The first part of the article discusses the development and operation of the planning methodology. This is followed by a discussion of the field test used to evaluate the planning methodology.

Planning Methodology

The use of some form of computer steering committee is commonly used in most organizations for computer planning and controlling purposes [13]. The committee is charged with providing strategic input for all university computing activities, i.e., academic and administrative. A committee is advocated to balance the power and reduce the conflict associated with computing resources [8]. Such a committee, if properly organized and operated, has the advantage of providing input from differentiated dimensions of an organization. For example, the committee might have representatives from each college or school, the major administrative areas (e.g., financial affairs and student records), and the computer center. An exact committee structure should be contingent upon the institutional setting.

The role of the committee should be strategic and advisory in nature; i.e., the committee should be involved in policy and resource allocation issues rather than operational issues. However, without some form of planning model to provide structure to resource allocation...
decisions, committees generally have difficulty coalescing their differentiated perspective into an operational plan [1, 10]. Therefore a planning model should be defined and agreed upon by the committee in order to structure their planning activities.

Development of the Planning Methodology

The planning methodology developed for this study is a hybrid system which incorporates philosophical concepts from the systems approach [14] and operational concepts from a planning programming budgeting system (PPBS) [7, 17] and zero-based budgeting (ZBB) [15]. Although PPBS and ZBB have received substantial philosophical support, in implementation they have been subjected to a great deal of criticism. Both planning techniques have been criticized for utilizing complex and rigid forms for describing programs or services. The difficulty of defining and fitting projects or services into planning documents has caused considerable frustration and distortion of actual operations [17]. PPBS has been further criticized for overemphasis on quantitative measures to assess program efficiency in qualitative areas that do not readily lend themselves to quantification (e.g., research and instruction) [6]. Although few individuals would question the desirability of good performance measurement, utilizing inappropriate and/or inaccurate measurement criteria will generally cause resentment in those subjected to it. The use of quantitative techniques in qualitative and even esoteric areas is still (and may remain) in a primitive state.

As a result of the experiences and criticisms of both PPBS and ZBB, specific care was taken in designing the planning methodology used in this study to keep the forms and procedures practical and to deemphasize quantitative performance measurement. The actual operation of the planning methodology is discussed below.

Operation of the Planning Methodology

For convenience, the overall strategic planning methodology is referred to as activity analysis. Operationally, the activity analysis planning exercise consists first of conceptually reducing the computing effort to zero-base (i.e., no computing effort). The next step consists of identifying all computer and computer-augmented activities (or services) which can be included in the computing effort. These may or may not be activities in which the computer effort currently engages. Once identified the activities are structured and separated into sequentially dependent incremental service levels requiring incremental resources. The components used to describe each activity level are as follows:

(a) activity name and level;
(b) definition;
(c) description;
(d) expected accomplishments;
(e) consequences of not doing;
(f) elements of cost;
(g) alternatives;
(h) review comments or suggestions.

These components are incorporated into an appropriately designed form with variable length fields used to accommodate varying documentation requirements. Emphasis in developing the activity analysis document centers on the end result of the service. Therefore technical jargon is minimized.

Several activities can be identified as part of the computing effort. Examples are listed below.

(a) Academic teleprocessing (computer terminals).
(b) Academic user services (consulting, programming, seminars, documentation, etc.).
(c) Administrative systems (the processing of payroll, registration, accounting, etc.).
(d) Computer operations.
(e) Computer output microfilm.
(f) Data conversion (card punch and data entry).
(g) On-Site user facilities (card punches, work areas, storage, etc.).
(h) Optical reading.
(i) Plotting.
(j) Systems performance analysis (assessing and timing computer performance).
(k) Systems support (operating systems development and maintenance).

Utilizing the activity analysis framework, each activity is structured into incremental and logical service levels. The service levels within activities, by definition, are sequentially dependent (i.e., level 1 of 2 must be supported before level 2 of 2). Possible structuring of the activities listed above are illustrated in Figure 1.

Priority assignment for each activity is accomplished through an iterative process in which committee members independently prepare a ranking of all activity levels starting from base zero. The rankings of all committee members are combined and average rankings and standard deviations are computed for each activity. The results of this tabulation are presented to the committee.

The reasons for ranking variances among committee members are discussed by the committee in an attempt to resolve differences in perception and opinion. Usually two to three iterations of the entire process are conducted which tends to significantly reduce variances in rankings among committee members. Once an overall ranking for the committee is agreed upon, the actual activity levels supported for the planning period become a function of the budget allocation for the period.

Because of the interaction between activities, some sequential dependency exists across activity levels. For example, the use of a computer terminal would not be possible without a computer to support it. When appropriate, this type of interaction is defined under the review comments and suggestions component of the activity analysis document.
A. Academic Teleprocessing
1. Limited academic teleprocessing network/interactive capability
2. Expanded academic teleprocessing network and RJE capability
B. Academic User Services
1. User assistance services and software and documentation services
2. Expanded programming and consulting services
3. Extensive educational services
C. Administrative Systems
1. Modification, maintenance and processing of existing administrative systems
2. Development of new batch systems
3. Online data entry
4. Database technology
D. Computer Operations
1. Small scale processor
2. Medium scale processor
3. Enhanced medium scale processor
E. Computer Output Microfilm
1. Service bureau support
2. In-house capability
F. Data Conversion
1. Basic card punch service
2. Key-to-diskette
G. On-Site User Facilities
1. Minimal facilities
2. Adequate storage, work areas, and card punch
3. Extensive work areas, card punch and storage
4. Semiprivate work areas
H. Optical Reading
1. Mark sense scanning
2. Optical data scanning
3. Optical character reading
I. Plotting
1. Local-basic two-dimensional capabilities
2. Interactive-basic two-dimensional capability
3. Three-dimensional plotting capability
J. Systems Performance Analysis
1. Analysis using standard machine statistics
2. Analysis using expanded machine usage statistics
3. Analysis using sophisticated hardware and software monitoring techniques
K. Systems Support
1. Partial reliance on vendor
2. No reliance on vendor
3. Extensive control logic development

The preparation of activity analysis planning documents is logically the responsibility of the computer center personnel and/or consultants due to technical considerations. However, once the documents have been prepared they are reviewed and approved by the computer service committee.

Figure 2 represents a ranking of three hypothetical activities—A, B, and C. Each activity consists of three levels. The cumulative cost of supporting each additional activity level is also illustrated.

If the funding level for a yearly period was $5800, activities up to and including C3 would be supported. Should the budget be increased, activity B2 would be the next to be supported. In the event of a budget decrease, activity C3 would be the first to be eliminated.

The advantages of starting at base zero (i.e., no computer center) are significant. For example, over time activity A2 may become less important than activities C3 and B2. If the importance of A2 declines and the funding remains at $5800, A2 should be eliminated and B2 should be added.

The structure provided by the activity analysis in systemically defining "what is" and "what can be" included in the computing effort is perhaps its most valuable dimension [14]. To say that users want computer terminals is not enough. Rather, the number, the type, and the necessary computer support must be precisely articulated. Only then can a committee assess what an activity consists of and how it compares to other activities. The segmenting of activities into specific activity levels allows well-defined negotiation among committee members in "tuning" the rankings of activities into a well-balanced service organization.

The activity analysis facilitates translating diverse and unstructured academic and administrative user requirements into a meaningful and executable planning base. Of course, to be effective, computer service committee members must solicit input pertaining to computer activities from associates in the members' related disciplines. To the extent a planning committee can achieve agreement on computing effort priorities, the more likely the plan will receive support from top management.

Figure 3 provides a systems overview of the strategic planning methodology. Input to the system can be viewed as a relatively consistent process with a major planning cycle executed on an annual basis. A planning cycle involves one or more ranking exercises starting from base zero which establishes the planning base for the year.

Further Planning of Administrative Systems

In Figure 1, administrative systems is identified as one of the major activities of the computing effort. The strategic decisions pertaining to resource allocations for this activity are performed by the computer service committee using the activity analysis. However, due to the specialized nature of planning and controlling administrative systems, further special direction for administrative systems is required once the resource allocation process has been accomplished.

The planning of administrative systems is accom-
plished by a separate MIS committee which represents major administrative functions of the institution. This committee uses the same activity analysis model to allocate administrative system resources among different administrative offices. In this case, activities are defined as specific information system development or maintenance projects. Once the projects to be accomplished for a planning period are defined, they are administered through project management [4].

The MIS committee concept coexists compatibly with the computer services committee. The MIS committee coalesces that portion of the computer services committee's recommendations pertaining to administrative computing service levels with state, regional, federal, and institutional considerations to develop strategic and tactical plans for management information systems.

Field Test

To ensure the operational viability of the proposed planning methodology, the authors conducted a field test. The field test utilized a modified form of an "after only with control group" design to test the validity of the research findings. The actual field test consisted of implementing the strategic planning methodology in a university computer center for a two-year period.

The computer service committee at the university implemented the activity analysis planning methodology on a pilot basis during the fall of 1974. Each committee member performed an independent ranking of activity levels and submitted it to the computer center for tabulation. The computer center then prepared the average ranking and standard deviation for all activities. At the second meeting of the committee, an attempt was made to resolve differences in rankings. Committee members performed another independent ranking, and the computer center tabulated the results. A third meeting of the committee was held at which time unanimous agreement was achieved for activity rankings.

After completion of the planning exercise, the activity analysis approach was unanimously adopted by the committee for future planning exercises. The planning technique received support from the top administration of the university as well as the division of budget and planning in the state governor's office.

The planning exercise for 1975–1976 was executed along the same lines as the previous year. Structural changes were made to several activities which significantly modified computing services. As might be expected, the difficulty of defining, structuring, and ranking activities was reduced significantly during the second planning effort. The activity analysis again unanimously was retained for future planning exercises. A significant redistribution of existing computer center resources occurred as the computing effort responded to the planning base.

Control Groups

The computing efforts of two sister institutions located in the same state as the test institution were used as a control group to strengthen conclusions derived from the results obtained from the test university. Some relevant areas of commonality among the three institutions are listed in Table I. The three universities were subject to the same state controls (and politics).
Hypotheses

A university computing effort's primary charge is to support the instructional, research, and administrative objectives of the institution. Accordingly, the effectiveness of a planning methodology should be evaluated in terms of its contribution to improving, over time, the computing effort's support of instruction, research, and administration. The effectiveness of this aspect of the planning methodology was tested with the following three null hypotheses.

HYPOTHESIS 1. Two years after implementing the planning methodology, attitudes toward the computing effort's support of instructional activities will not indicate a greater improvement among faculty at the test institution than at the control institutions.

HYPOTHESIS 2. Two years after implementing the planning methodology, attitudes toward the computing effort's support of research activities will not indicate a greater improvement among faculty at the test institution than at the control institutions.

HYPOTHESIS 3. Two years after implementing the planning methodology, attitudes toward the computing effort's support of administrative activities will not indicate a greater improvement among administrators at the test institution than at the control institutions.

The computing requirements of the academic and administrative sectors of the university are usually mutually exclusive. Thus, a conflict for available resources often arises. An effective planning methodology should properly address overall institutional (both academic and administrative) requirements. Proper and fair allocation of the computing resources will tend to be perceived as such by both the faculty and administration. The quality of the allocation of computing resources was tested with two null hypotheses stated as follows.

HYPOTHESIS 4. Two years after implementing the planning methodology, attitudes toward the allocation of computing resources will not indicate greater improvement among faculty at the test institution than at the control institutions.

HYPOTHESIS 5. Two years after implementing the planning methodology, attitudes toward the allocation of computing resources will not indicate greater improvement among administrators at the test institution than at the control institutions.

Facilitating user input to the planning process for the computing effort is generally considered desirable. Accordingly, a well-organized planning methodology should incorporate the mechanisms for user input to the planning methodology. The ability of the proposed planning methodology to facilitate user input was tested with the following null hypotheses.

HYPOTHESIS 6. Two years after implementing the planning methodology, the attitudes of the faculty at the test institution will not indicate greater improvement in perceived ability to have input to the planning of the computing effort than at the control institutions.

HYPOTHESIS 7. Two years after implementing the planning methodology, the attitudes of administrators at the test institution will not indicate greater improvement in perceived ability to have input to the planning of the computing effort than at the control institutions.

HYPOTHESIS 8. Two years after implementing the planning methodology, attitudes pertaining to the allocation of computing resources among administrative offices for the development and maintenance of administrative information systems will not indicate greater improvement among administrators at the test institution than at the control institutions.

A university's computing effort can offer a multiplicity of computer and auxiliary services and facilities. These services and facilities can be categorized as follows:

- (1) card punch machines;
- (2) work areas (tables, chairs, storage facilities);
- (3) consulting assistance for students;
- (4) consulting assistance for faculty;
- (5) user documentation (reference manuals, user's guide, newsletters, etc.);
- (6) user training sessions;
- (7) programming services for user projects;
- (8) state-of-the-art computing equipment;
- (9) processing of computer jobs;
- (10) access to computer equipment (hands-on operation);
- (11) specialized software (e.g., statistical and simulation packages);
(12) academic interactive computing (i.e., the use of computer terminals);
(13) administrative interactive computing (i.e., the use of computer terminals);
(14) computer plotting facilities;
(15) optimal reading facilities (i.e., scanning of coded documents);
(16) computer output microfilm (i.e., converting computerized data to film).

With limited resources, particular emphasis needs to be placed on synchronizing the level of each service offered with the importance of that service. The importance assigned to a service should be a function of the requirements of the users of the services. Understandably, the importance of the various services will tend to vary among institutions. The planning methodology should, therefore, improve the alignment of the importance and the adequacy of services offered. This was tested with the following null hypothesis.

**Hypothesis 9.** Two years after implementing the planning methodology, the improvement in the correlation between the importance and the adequacy of service levels will not be greater at the test institution than at the control institutions.

The overall perception of the computing service organization is important for continued institutional support. The ability of the proposed planning methodology to contribute to the overall perception was tested with the following null hypothesis.

**Hypothesis 10.** Two years after implementing the planning methodology, overall attitudes toward the computing effort will not improve to a greater degree at the test institution than at the control institutions.

**Procedure**

The data to test the ten hypotheses were obtained from two separate attitudinal questionnaires, one administered to faculty and the other to administrators. The questionnaires are used as a surrogate for more direct but less meaningful qualitative performance measures of each activity. This surrogate approach to assessing effectiveness of computing services is proposed by Nolan and Sward [12]. Both the faculty and administrative questionnaires used seven-point semantic differential scales to ascertain respondent's attitudes toward particular aspects of the computing effort. The respondents were asked to indicate the importance they attached to each dimension and also its adequacy during different time periods.

Both the faculty and administrative questionnaires referenced the 1974-1975 and 1975-1976 academic years. The administrative questionnaire also asked the respondent to project his/her attitudes two years into the future. This was operationally possible since administrators are generally aware of future plans for computing. The importance of obtaining a "future" perspective of administrators is based on the concern that it would take longer to implement strategic decisions in the administrative area than it would in the academic area. Therefore it may require a longer period of time to assess the impact of the planning methodology. For example, a decision can be made to install additional card punch machines for academic users. This can be achieved in approximately three months if funds are available. The major constraint for implementing more card punch machines would be hardware delivery. However, a decision to install an on-line financial information system will likely require more than two years. Accordingly, the impact of an on-line system would require a longer time frame.

Both questionnaires were pretested (and consequently modified) to ensure that respondents understood the questions and were able to accurately reflect their attitudes.

**Selection of Respondents**

The criteria for selecting respondents was straightforward. All faculty or chief administrators who had utilized the computing service regularly for two or more years were surveyed.

The chairperson of the computer services committee and the directors of the computer centers at the three institutions distributed and collected the questionnaires in May 1976.

**Orientation of Analysis**

Because of the nature of the research design, it is possible to consider the data collected as representing either a population or a statistical sample. A population orientation is justifiable since virtually all members of the population of each institution were surveyed. Viewing the data as a population does limit the scientific justification for the transferability of the experiment results. However, a reasonable verbal justification can be developed posing that the results of this study should be transferable to other institutions.

Alternatively, one could consider the data as a representative sample of a great number of universities, though certainly the sample would have to be classified as judgmental. To the extent one is willing to accept this position, statistical testing is appropriate. Statistical inferences would facilitate a stronger case for the scientific justification of the transferability of the results to other institutions.

The authors consider a population orientation to be the most appropriate for the purposes of this study. This position is reasonable since the data collected do represent a population. However, for those individuals interested in or willing to take a sample orientation, statistical testing was conducted.
Analysis

Each hypothesis was tested by analysis of responses to a questionnaire. The specific statistical test used to evaluate each hypothesis is presented in Table II. The analysis was designed to assess the improvement in the adequacy of the computing support effort as it pertains to the major institutional roles of instruction, research, and administration. Though not essential to perform the analysis of these hypotheses, it was expected and desirable that the respondent’s assessment of the importance of each of these activities would be similar at all institutions. For example, the importance of computing support for instructional purposes should not significantly vary from one institution to another. To ensure that this was the case, an analysis of variance was conducted comparing the average importance of the particular aspect of instruction, research, and administration being tested by each hypothesis. The results of this analysis did indeed indicate that the importance of activities tested by these hypotheses was not significantly different. This allows the testing of the adequacy of the activities for each hypothesis to proceed on the basis that the importance of each activity is basically the same at all three institutions.

One other possible area of concern pertaining to the analysis of data is the number of respondents at each institution that served on the computer services committee. However, the number turned out to be negligible. There were four or less faculty respondents serving on the computer services committee at the three institutions. There were two or less administrators.

Data analysis was accomplished by assessing the change in attitudes and/or utilization for two years for the test and control groups. This was accomplished by first scoring the questionnaires by quantifying the seven points of the semantic differential scales as integers. The characteristic which was then examined for all hypotheses, except for Hypothesis 4, was the average improvement for each item. With a population orientation, a null hypothesis was rejected if the average improvement for the test group was higher than that of the universities comprising the control groups.

Hypothesis 9 was tested by performing a Pearson correlation analysis between the importance and adequacy of each service offered. The correlation coefficients were transformed using Fisher’s “z” transformation and the total improvements in the values of “z” for each group was compared. The “z” transformation is necessary since correlation coefficients are not normally distributed. The null hypothesis was rejected if the test group demonstrated greater correlation than the control groups.

Findings and Conclusions

The analysis of the strategic planning methodology consisted of testing the ten operational hypotheses which were designed to systematically assess the effectiveness of the planning methodology [16].

The hypotheses were designed as a basis for assessing the computing effort’s support of instructional, research, and administrative activities of the institution. One hypothesis also was tested to assess the alignment between the importance and the adequacy of all major services offered by the computing efforts.

The data collected indicated that all three institutions improved their delivery of computing services during the two-year period. This was anticipated since improvements in technology and general progress will usually be translated into improved delivery of services. However, the improvement of the test institution consistently exceeded that of the control institutions. This was reflected in the fact that all ten of the null hypotheses were rejected using a population orientation. With a sample orientation, Hypotheses 3, 5, 7, and 8 failed significance tests for Control University II at the 5 percent level. Hypothesis 5 for Control University I and Hypothesis 8 for Control University II did indicate significance differences at the 10 percent level. If a 10 percent significance test was used as the rejection criteria, then only Hypotheses 3, 5, and 7 would fail significance tests for Control University II. The four hypotheses failing significance tests all pertain to the administrative aspects of the effectiveness of the planning methodology. As previously discussed, it was considered likely that improvements in the administrative area would involve a longer lead time. Therefore data was collected on the administrators’ attitudes for the computing services planned for
two years into the future. Statistical testing of this data indicates a significance difference between the test and the control groups at the 5 percent level for all hypotheses except for Hypothesis 7 for Control Group II. Therefore improvement achieved by the planning methodology initially was most pronounced in the instructional and research sectors. The improvement in the administrative area was eventually as pronounced as that in the academic area, but required longer to take effect.

The results of this study indicate that the planning methodology is viable from an operational perspective and effective in aligning the computer effort with the interests of the institution. It is important to realize that the results of a field test can be tempered by factors other than those specifically under consideration. For example, it is quite possible, and even likely, for the improvement achieved at the test institution to be a function of factors other than the planning methodology (e.g., interpersonal and technical skills of computer center personnel). Also, the lack of homogeneity of the test and control groups decreases the intensity of the information derived from the research. Unfortunately this is a reality and a limitation of the field test approach to research. From a judgmental perspective, there was nothing about the three institutions that represented a major difference other than the larger budget of Control University II. However, the reader is cautioned to consider possible bias in the research results due to factors other than the planning methodology.

The use of control groups proved most appropriate, as all three institutions generally demonstrated progress even though the computing budgets at all three institutions were relatively stable. It is not surprising to see improvement at all three institutions considering that the technology associated with computing is continually offering more advantageous cost/benefit ratios. These improvements in technology can be translated into more and better services to computer users which again emphasizes the importance of the control groups. Without the ability to factor out the control groups’ improvement from the test group’s improvement, the effectiveness of the planning methodology would have been inflated.

The impact of the planning methodology apparently does require more time in the administrative area than in the areas of instruction and research. However, though taking longer, the impact in the administrative area does appear eventually to be as significant. Overall, the balance with which the planning methodology addressed instructional, research, and administrative functions is commendable. It is possible for an institution to shift resources from one or more function(s) to another in order to achieve substantial progress in one area, such as administration, while sacrificing computing support in other areas, such as instruction and research. However, for a computing effort to be responsible and remain politically viable, balancing the pressing and often conflicting computing requirements of instruction, research, and administration is essential. The planning methodology discussed in this article appears to achieve a balance.

As a final note, the objective of developing the planning methodology was to improve the delivery of computing services. However, there is an interesting and unanticipated accomplishment that occurred three years after implementation of the planning methodology. The test institution took a $44,250 (15 percent) voluntary operating (nonpersonal) budget cut. Also, one and a half positions were phased out with normal attrition resulting in another $18,000 annual savings.

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